I-77 Feasibility Study

Executive Summary

Task Order No. 2

I-77 HOV-to-HOT Lanes Conversion

March 2010

Study Background

Existing I-77 High-Occupancy Vehicle Lanes

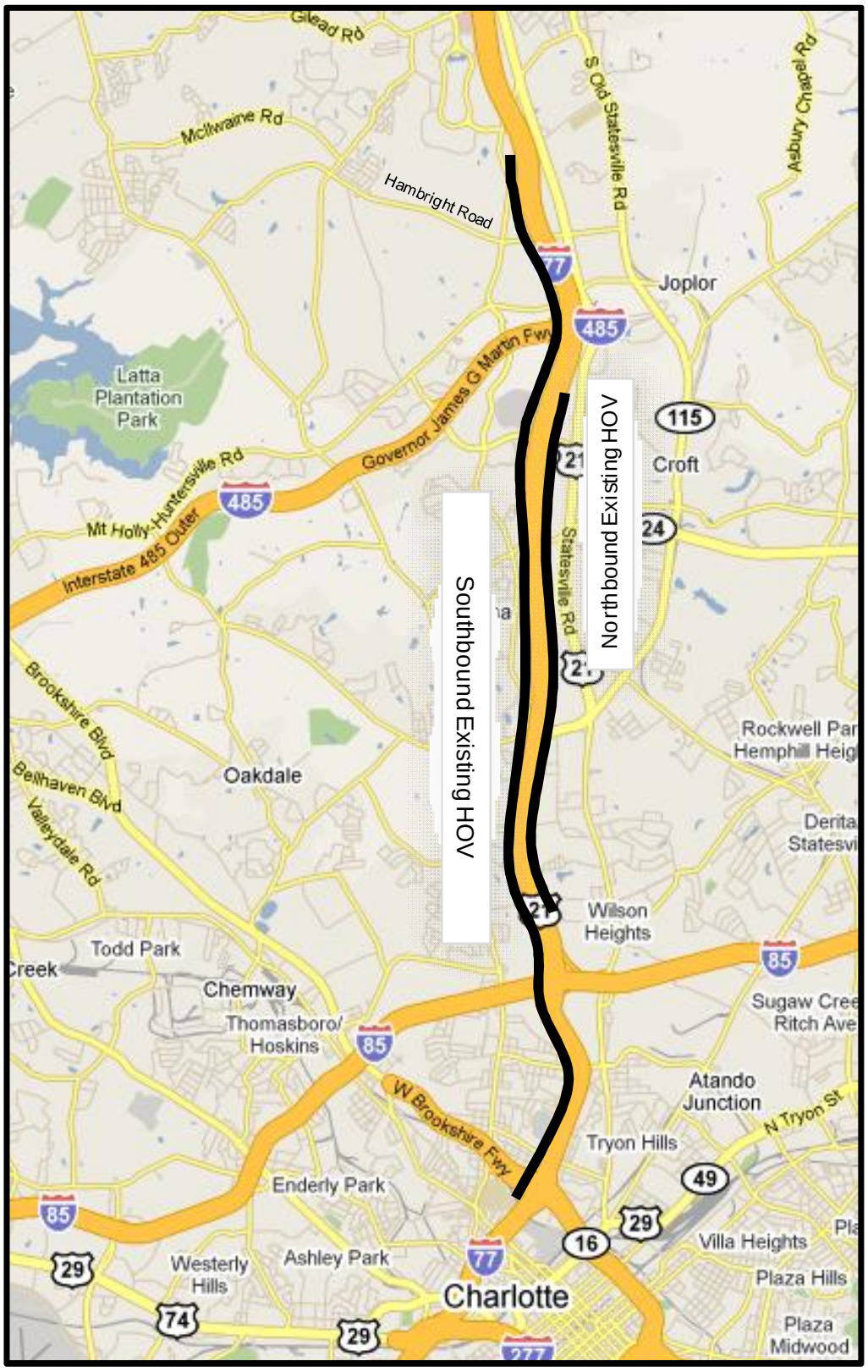
The North Carolina Department of Transportation (NCDOT) opened the existing I-77 high-occupancy vehicle (HOV) facility in December 2004 as part of a design-build project which widened the interstate from four to eight lanes between I-85 and I-485. The facility consists of a concurrent flow lane located next to the median in each direction of I-77. Access to the lanes is restricted at selected areas as denoted by double solid white lines. A wide skip white line indicates where access to the HOV facility is permitted.

In order to provide an acceptable terminus for the southbound I-77 HOV facility, an HOV-only ramp was constructed across I-85 (**Figure ES-1**). The southbound I-77 lanes and shoulders were narrowed to extend the HOV lane past the general purpose exit ramp for I-277 (Brookshire Freeway). This extension enables southbound vehicles using the HOV facility to merge out of the dedicated lane where I-77 morning peak traffic volumes are lower. The southbound I-77 HOV lane is about 10 miles long.

Figure ES-1: Southbound HOV Only Access Ramp

The northbound I-77 HOV lane begins ½-mile north of the I-85 interchange and ends at I-485, a distance of about 5 miles. Designation of the median lane as an HOV lane begins far enough north of the I-77 entrance ramp from I-85 so that vehicles, particularly trucks, can safely merge from this lane into the leftmost general purpose lane. The HOV designation for the northbound median lane extends beyond Harris Boulevard and is dropped prior to the I-485 interchange. The HOV lane becomes a general purpose lane at this point. **Figure ES-2** shows the beginning and ending points of the I-77 HOV lanes.

Figure ES-2: Existing HOV Lanes



Key I-77 HOV facility facts include:

- Restricted to high occupancy vehicles 24 hours a day, seven days a week.
- Restricted to vehicles with two or more occupants except for motorcycles, emergency vehicles when responding to an emergency, and buses.
- The North Carolina State Highway Patrol (NCSHP) randomly conducts enforcement as part of normal enforcement duties.
- About 300 vehicles use the HOV facility in the peak hour.

Charlotte Region *Fast Lanes* Study

From 2007 to 2009, NCDOT and local governments in the Charlotte region examined the existing and planned major highways throughout a 10-county area to identify where HOV and/or high-occupancy toll (HOT) lanes could improve roadway capacity. The Charlotte Region *Fast Lanes* Study covered 12 primary corridors, totaling about 334 miles of freeways and arterials. The study used a two-phase process to determine which regional highways showed the greatest promise for managed lanes treatments. **Figure ES-3** indicates the corridors evaluated in this regional planning effort, highlighting those corridors, which advanced into Phase 2.

Travel demand for HOV or HOT lanes in the I-77 North corridor ranked near the top of corridors assessed in Phase 2 of the regional study. The forecasted travel time savings for *Fast Lanes* users in 2030 would exceed the industry rule-of-thumb of a half-minute per mile savings. These results were based on development of a regional managed lanes network. The *Fast Lanes* study concluded that I-77 North should be analyzed at a corridor level for HOV lanes extension and/or HOT lanes implementation.

I-77 Feasibility Study, Project FS-0810B

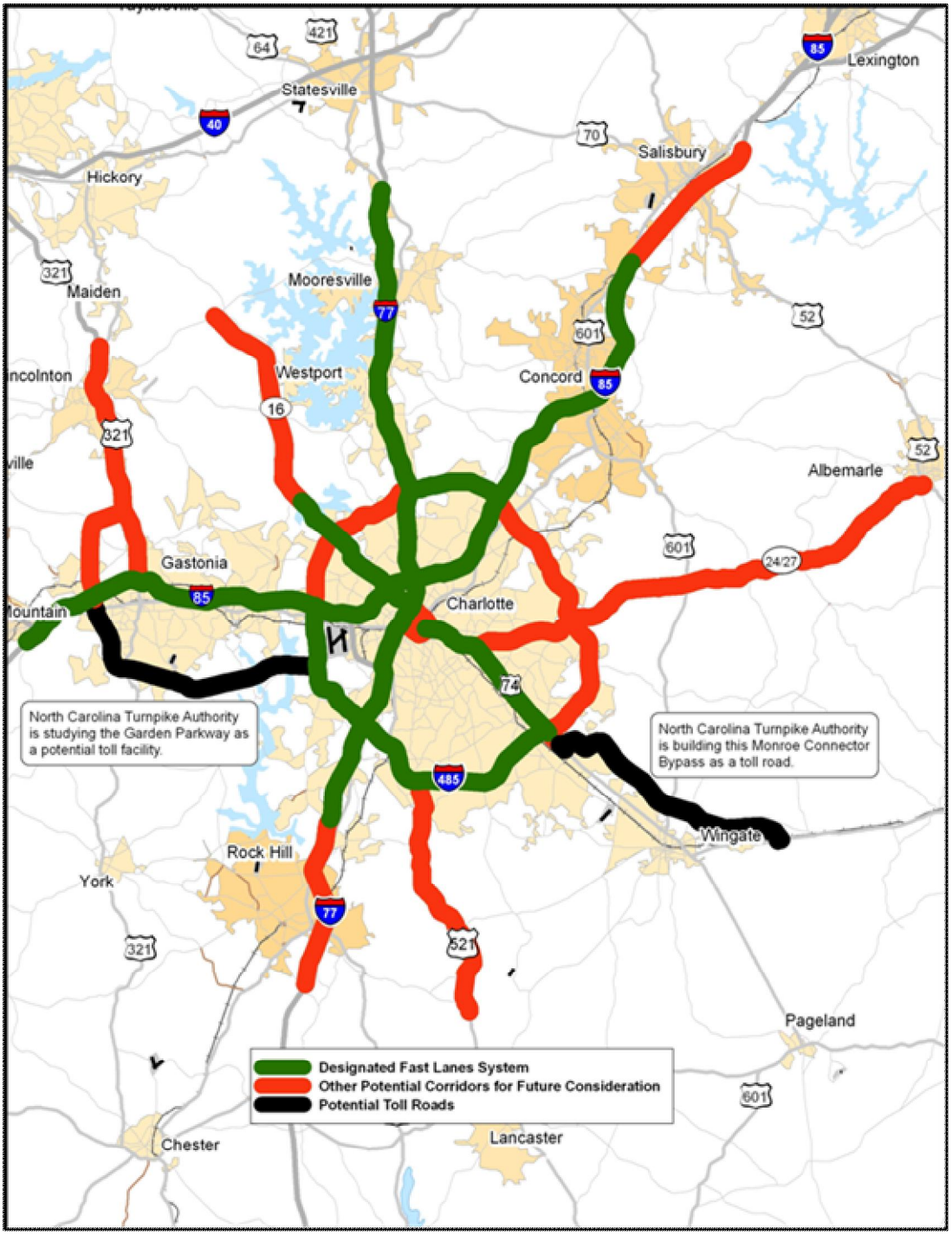
In February 2009, NCDOT sponsored a feasibility study for I-77 between I-85 and Griffith Street in Davidson consisting of three separate task orders:

- **Task Order No. 1** – Analyze the feasibility of widening I-77 to eight lanes, including the extension of the existing HOV lanes from the current terminus located at I-485 to Griffith Street. The task order also examined the feasibility of widening I-77 to six lanes in this area by simply extending the HOV lane between I-485 and Griffith Street. The task order identified issues, design modifications, benefits and costs associated with I-77 widening, which included HOV facility extension, for both six and eight-lane alternatives.

- **Task Order No. 2** – Analyze the feasibility of converting the existing HOV lanes to HOT lane operations. A second option involved converting the existing HOV facility to HOT lanes plus extending only the HOT lane from the current HOV facility terminus at I-485 to Griffith Street. A third alternative included converting the existing HOV facility to HOT lanes plus adding a HOT lane and a general purpose lane in each direction between the current HOV facility terminus and Griffith Street. This task order identified issues, design modifications, revenue potential, benefits and costs associated with the aforementioned three alternatives.

- **Task Order No. 3** – Determine the advisability of temporarily converting the outside shoulders along I-77 between I-485 and Catawba Avenue to travel lanes for general purpose traffic on either a part-time or full-time basis. The task order identified operating strategies, design modifications, benefits and costs associated with I-77 shoulder use.

Figure ES-3: Evaluated Corridors in Charlotte Region *Fast Lanes* Study



Analysis Results for Task Orders No. 1 and 3

Under Task Order No. 1, two HOV facility extensions were analyzed in detail:

- If the HOV lane only was extended, it could end at Catawba Avenue with adequate provisions for merging traffic particularly in the afternoon peak period. The construction cost for the extension was estimated at $39 million.

- If two lanes were added in both directions of I-77 north of I-485, the causeway located between Griffith Street and Langtree Road would have to be widened to six lanes. The proposed eight-lane section would extend to Catawba Avenue with six lanes continuing to Langtree Road. This cross-section would be needed in order to prevent a bottleneck in the afternoon from merging traffic where the northbound HOV lane ends. The cost of extending the general purpose and HOV lanes was estimated at $74 million.

Under Task Order No. 3, the provision of a third lane in both directions between I-485 and Catawba Avenue from upgrading the shoulders and allowing general purpose traffic to use them would provide significant travel benefits to motorists. However, the shoulders along this portion of I-77 would require full rebuilding, at an estimated cost of $20 million, to handle traffic. Adding another lane in the grass median, which is available for widening, would provide similar benefits without the safety issues associated with shoulder use.

Analysis Results for Task Order No. 2

Conversion of the existing HOV lanes to HOT and expanding project limits further north was deemed feasible. A specific alternative was investigated in more detail, and the findings are presented in this section.

Recommended HOT Lanes Alternative

The recommended alternative for Task Order No. 2 involves the following construction:

- Conversion of the existing I-77 HOV facility to HOT lanes.
- Extend a single HOT lane in each direction from the current northern terminus at I-485 to Catawba Avenue in Cornelius.
- Designation of the northbound HOT lane would end ½-mile south of Catawba Avenue with general purpose traffic merging to the leftmost lane (HOT facility users would have priority); the outside general purpose lane would drop at the Catawba Avenue interchange.
- The southbound HOT lane begins south of the southernmost causeway located between Catawba Avenue and Griffith Street.
- No construction would occur along the I-77 causeway due to impacts of environmental review on the project schedule and the likely cost impacts associated with mitigation. A longer-term time horizon is needed for capacity improvements in this section.

The proposed I-77 HOT lanes would operate as follows:

- 24/7 operation (same as current HOV facility operations)
- Electronic toll collection only with the same transponders and license plate recognition technology as other North Carolina toll facilities
- Buses, emergency vehicles (when responding to an emergency) and vehicles with two or more occupants travel for free.
- Two-axle trucks, such as delivery vehicles, could pay to use the HOT lane, but three-axle trucks would be prohibited.
- Access to the HOT lanes would be allowed at designated areas, indicated by a wide white skip line. Access restrictions would be denoted by two wide solid white lines defining a non-traversable buffer.

The benefits of the proposed I-77 HOT lanes include:

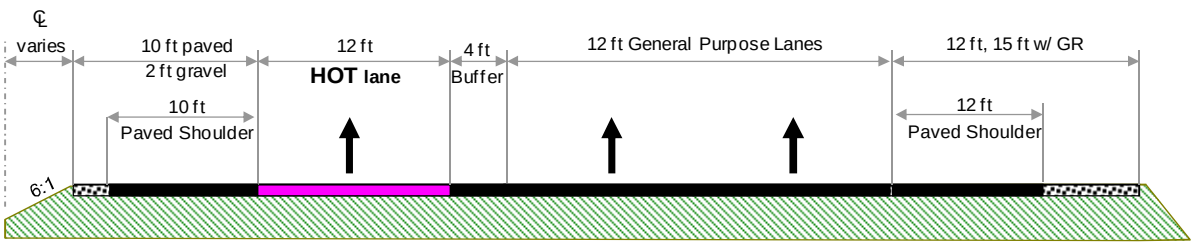
- Makes better use of existing HOV lanes by permitting access to additional vehicles.
- Offers more choices for I-77 commuters.
- Provides an incentive for increased transit use and ridesharing because of the longer dedicated facility, resulting in shorter commuting times.
- Improves travel times in general purpose lanes based on the number of HOT lanes users.
- Represents an opportunity to convert HOV facility violators to paying customers.
- Takes advantage of toll technology and operating procedures being implemented by NCDOT along the Monroe Parkway.

HOT Lanes Facility Design

The design principles used for the I-77 HOV-to-HOT lanes conversion are similar to those employed along the existing HOV facility south of I-485 as well as other HOT lanes conversions in other cities around the country. At this planning stage, no design exceptions are likely to be required.

The HOT and general purpose lanes would be 12-feet wide with a 4-foot painted buffer between the HOT and general purpose lanes. The inside (left) paved shoulder width would be 10 feet while the outside (right) paved shoulder width would be 12 feet. No reductions from full design widths would be necessary. **Figure ES-4** shows the typical section for the recommended alternative.

Figure ES-4: HOT Lane Typical Section



Plastic tubes or pylons would not be used in the buffer area to separate the HOT lanes from general purpose lanes because of maintenance costs and close proximity to high-speed traffic. A minimum 1000-foot per lane weave distance for each general purpose lane would be applied between right-side ramps and designated HOT lanes weave areas. Vehicle detection would be provided from the side of the facility or overhead.

Safety is a major consideration when evaluating HOT lane facility design elements. The available right-of-way and median of I-77 generally allow for all desirable design components to be included. These features include 12-foot lane widths, inside breakdown shoulders and buffer separation to address the potential speed differential between HOT and general purpose lanes. NCSHP and Charlotte police officers have safely used the 10-foot inside shoulder for enforcement purposes since the HOV lanes opened in 2004.

Intermediate access to the HOT lanes would be similar to the approach taken for the HOV lanes. Motorists would be permitted to enter and exit the HOT lane only at designated breaks in the solid pavement markings. These locations coincide with operational settings that match major ingress and egress demand to and from right side ramps, and located to allow for a minimum of 600 feet and desirably 1000 feet per general purpose lane for merging and weaving between the left and right sides. Intermediate access would be spaced about every two to three miles.

Termini treatments at either end of the proposed HOT lanes facility are designed to match merging traffic demand with through travel movements so that bottlenecks don't occur.

Forecasted Travel Demand and HOT Lanes Revenue

Travel demand and HOT lane revenues were forecasted using a special planning model developed specifically for this type of high-level feasibility study. The sketch model used output from the regional travel demand model to estimate that roughly 1600 vehicles would be using the proposed HOT lanes during peak periods in 2013 and 2030.

The primary purpose of the tolling model is to project HOT lane revenues if the recommended alternative was implemented along I-77. The model forecasted annual revenues based on relationships observed in other cities between weekday peak period revenues and amounts generated in off-peak periods, including weekends. Based on the results of the sketch model, gross revenues are forecast to grow in 2007 dollars from $3.9 million in the opening year to $5.5 million in 2030 if the I-77 HOT lanes were extended to Griffith Street. This forecast was used to estimate gross revenues for the recommended extension to Catawba Avenue at $3.7 million in 2013 and $4.7 million in 2030, both expressed in 2007 dollars.

Estimated Capital and Operations and Maintenance (O&M) Costs

Based on a functional design for the recommended alternative, construction cost estimates were prepared using NCDOT's latest preliminary estimates cost index. The estimated construction cost for adding a lane in each direction for this seven-mile section of I-77 is approximately $39 million, expressed in 2009 dollars. The tolling system required for HOT lanes operation includes gantries, transponder readers, and information displays. The cost for this equipment, estimated at $11 million in current year dollars, takes advantage of economies of scale from planned toll road operations by the North Carolina Turnpike

Authority (NCTA). The total estimated cost for the recommended I-77 HOT lanes alternative is $50 million in current year dollars.

Estimated costs for fixed toll facility operations (toll system maintenance, Intelligent Transportation Systems (ITS) maintenance, enforcement and motorist assistance) and variable toll expenses (transaction processing and violations processing) reflect the latest NCTA assumptions for this business unit's planned turnpike projects. Costs for highway maintenance and set-asides for major capital re-construction of the I-77 HOT lanes are not included because of the traffic management objective of the facility. This assumption parallels other HOT facilities which are in operation or under development where the primary objective for lane implementation is traffic management, rather than maximizing toll revenues.

Conceptual Financial Feasibility Analysis

The task order included a conceptual financial feasibility analysis for the recommended alternative. Two financial approaches were analyzed to help illustrate a range of public and private financing options that may be available for the I-77 HOT lanes facility. The financing approaches would depend on the appetite for such investments by the private sector at the time the facility is implemented, and the State of North Carolina's ability to raise funds for the project. The two approaches include:

1. **Public Debt Transaction:** Under a traditional public debt financing, the HOT facility would be owned, operated, and maintained by a public entity such as NCDOT. The net toll revenue from the facility could be used to repay non-recourse tax exempt municipal debt issued by the State or a State entity to offset some of the capital costs associated with the facility's construction. NCDOT would need to procure the balance of the capital cost above what is raised in the toll revenue bond transaction and pay for any routine HOT lanes roadway maintenance costs. The capital cost gap could be addressed by the State issuing general obligation debt or through normal avenues of project funding with State or Federal allocations.

2. **Public-Private Partnership Availability Payment Concession:** The availability payment concession would require that NCDOT procure a private entity to partner with in designing, financing, building, operating, and maintaining the HOT facility with private money in exchange for a series of annual payments from the State that would allow the private partner to recoup their investment and a reasonable return. Under this scenario, the facility would be built by the private entity but owned by the State. It would be leased for a 30-year period to the private entity that would operate and maintain the facility to standards set by NCDOT. An availability payment transaction could be structured in a number of ways, mixing public and private funding for the project, but a full concession transaction that excludes public capital funding was studied in order to show the opposite end of the spectrum from the pure public debt approach.

Both scenarios would depend on stable credit markets making borrowed funds available for toll related projects. The State's credit rating must remain strong, as it is today, for any solo or partnering engagements involving State credit to be cost efficient. Finally, either of the two approaches could potentially incorporate borrowing through the United States

Department of Transportation (USDOT) Transportation Infrastructure Finance Innovation Act (TIFIA) which is available to public and private entities to help lower the cost of capital for revenue generating projects such as HOT lanes and other tolled facilities.

Table ES-1 shows forecasted toll revenues and O&M costs between 2013 and 2030 in year-of-expenditure dollars. Assuming toll revenues would grow 3 percent annually, year-of-collection gross toll revenues for the recommended HOT lanes alternative are expected to be $4.2 million in 2013 and $8.9 million in 2030[1]. Subtracting annual project costs from revenues provides the forecast for net revenue available for debt service or other uses.

Table ES-1: Annual Project Revenues and O&M Costs (Year-of-Expenditure Dollars)

Year	Gross Toll Revenue	Variable Costs	Fixed Costs	Total Costs	Net Revenue
2013	**4,207,800**	782,600	1,213,300	**1,995,900**	**2,211,900**
2014	**4,481,800**	813,300	1,249,700	**2,063,000**	**2,418,800**
2015	**4,755,900**	845,100	1,287,200	**2,132,300**	**2,623,600**
2016	**5,029,900**	878,100	1,325,800	**2,203,900**	**2,826,000**
2017	**5,304,000**	912,300	1,365,600	**2,277,900**	**3,026,100**
2018	**5,578,100**	947,800	1,406,600	**2,354,400**	**3,223,700**
2019	**5,852,100**	984,600	1,448,800	**2,433,400**	**3,418,700**
2020	**6,126,200**	1,022,800	1,492,200	**2,515,000**	**3,611,200**
2021	**6,400,200**	1,062,300	1,537,000	**2,599,300**	**3,800,900**
2022	**6,674,300**	1,103,400	1,583,100	**2,686,500**	**3,987,800**
2023	**6,948,400**	1,145,900	1,630,600	**2,776,500**	**4,171,900**
2024	**7,222,400**	1,190,000	1,679,500	**2,869,500**	**4,352,900**
2025	**7,496,500**	1,235,600	1,729,900	**2,965,500**	**4,531,000**
2026	**7,770,500**	1,283,000	1,781,800	**3,064,800**	**4,705,700**
2027	**8,044,600**	1,332,100	1,835,200	**3,167,300**	**4,877,300**
2028	**8,318,700**	1,383,000	1,890,300	**3,273,300**	**5,045,400**
2029	**8,592,700**	1,435,700	1,947,000	**3,382,700**	**5,210,000**
2030	**8,866,800**	1,490,300	2,005,400	**3,495,700**	**5,371,100**

Public Debt Transaction

The public debt transaction approach is described in detail because it represents the most likely financing approach for the I-77 HOT lanes project. The overall goal of the public debt transaction financial capacity analysis is to estimate the HOT lane's contribution toward the project's capital costs that could be generated by borrowing against future toll revenues. This analysis includes the following assumptions, some of which have been taken from other similar toll road financings and could be expected to apply to this project.

a) Issuance Year: Debt issuance would occur at the end of 2011 such that the facility could be built and operational at the end of 2013.

[1] Gross Revenues shown in Table ES-1 are net of expected leakage from uncollectable transactions estimated at 4 percent.

b) **Debt structure**: A split of non-recourse senior current interest bonds (CIBs) and senior capital appreciation bonds (CABs) has been structured with the majority of debt issued in CIBs. No subordinate debt has been modeled.

c) **Term of Bonds:** 30 years

d) **Estimated Borrowing (Interest) Costs:** A flat yield curve at 6.0 percent for CIBs and 6.5 percent for CABs has been assumed. These rates are in line with historical average borrowing yields over the past 10 years for BBB-rated issuers, though the yield curve is typically upward sloping. The market for non-recourse toll revenue debt has been volatile in recent years. The ability of the project to borrow at these rates will depend on the market at the time of issuance. If interest rates do not realign with historical yields, the project may require credit assistance from the State to achieve these rates. If a TIFIA loan is incorporated into the financing, the overall blended borrowing rate could be significantly reduced. Up to 33 percent of eligible project costs can be financed through TIFIA, so assuming a 4 percent TIFIA rate, the overall blended borrowing rate could be reduced to less than 5.5 percent.

e) **Debt Service Reserve Fund (DSRF):** A DSRF is typically required for toll road bond issues and is sized to equal the lower of maximum annual debt service, 10 percent of the par amount issued, or 125 percent of average annual debt service. For simplicity, this analysis uses 10 percent of the par amount.

f) **Capitalized Interest:** A two-year project build timeframe has been modeled, such that some debt service payments will need to be made prior to the HOT facility becoming operational. These payments have been capitalized in the overall loan amount.

g) **Cost of Issuance:** Typically, bond underwriters and others involved in selling the bonds and closing the transaction are paid as a percentage of the bond proceeds. This analysis assumes these costs add 4 percent to the par value.

h) **Debt Service Coverage:** Debt service coverage measures the ratio of net toll revenues to the annual debt service payment. Coverage is expressed as a ratio - the multiple of net revenues to debt service - and is set according to the perceived risk of the revenue stream. Because of the greater degree of uncertainty in the forecasts for a dynamically priced HOT lane facility where the alternate route is an adjacent free lane, combined with non-recourse debt placing the traffic and revenue risk squarely with the bondholders, a debt service coverage ratio of 2.0 times has been assumed. This means that the annual debt service would be limited to one-half of the projected net revenues (net revenues need to cover debt service by a factor of 2). This ratio could be lowered to perhaps 1.5 times if there were some credit enhancement such as a State backstop on the debt effectively transferring some of the traffic and revenue risk from bondholders to the State. The use of a subordinated debt in the form of a TIFIA loan in the financing would lower overall financing coverage even more, as the coverage on TIFIA loans are typically below 1.25 times.

The debt service coverage ratio used to calculate the debt capacity has a significant impact on the amount of project funding that can be raised from tolls. Coverage does not take away toll revenues from the project; it just limits the extent to which they can be borrowed against. If toll revenue projections are met, the additional cash flow

represented by coverage would become available to the issuer for use in funding capital maintenance or other pay-as-you-go capital improvements at their discretion.

Incorporating the assumptions listed above, the net cash flows for 2013 to 2041 (adjusted for coverage) were discounted back to 2011 and reduced by reserve and cost of issuance factors. **Table ES-2** provides a summary of the transaction results, showing that $21.7 million could be made available through toll revenue bonding to apply towards the construction of the HOT facility, offsetting 38 percent of the $56.9 million total year-of-expenditure project cost.

Table ES-2: Municipal Debt Transaction Summary

Total Toll Revenue CIB Issuance	14,180,000
CIB DSRA Deposit	(1,420,000)
CIB Issuance Costs	(570,000)
CIB Proceeds For Construction	12,190,000
Total Toll Revenue CAB Issuance	11,110,000
CAB DSRA Deposit	(1,110,000)
CAB Issuance Costs	(440,000)
CAB Proceeds For Construction	9,550,000
Total Bond Proceeds	***21,740,000***

The TIFIA loan program, which was mentioned earlier, could provide more favorable terms for I-77 HOT lanes financing. To illustrate this and show the sensitivity of the financial model to changes in assumptions, a scenario was performed using a TIFIA loan and the public debt transaction approach. As shown in the above table, $21.7 million in toll revenue bond proceeds could be expected under the public debt approach. If a TIFIA loan representing 33 percent of the project costs were incorporated, the average coverage ratio on this debt could be lowered to approximately 1.6 times and the average interest rate could fall by about 100 basis points. The impact of these factors would be an increase in the bonding capacity of the HOT lane revenue stream, raising the construction proceeds from $21.7 million to $31.3 million. Under this scenario, toll revenue bonding would offset 55 percent of the $56.9 million total year-of-expenditure project cost.

While the benefits that a TIFIA loan can provide to the project are significant, it is important to note that TIFIA is a competitive program currently oversubscribed with limited lending capacity. Although the I-77 HOT lanes may be a good candidate for the program, there is no guarantee that the project will receive a TIFIA loan.